

UNIVERSITY OF MICHIGAN LIBRARY

Transactions, American Geophysical Union

Vol. 64 No. 27 July 5, 1983

EOS



Sym-iti Akimoto
1983 Bowie Medalist

EOS, Transactions, American Geophysical Union

Vol. 64, No. 27, Pages 441-448

July 5, 1983

AGU (cont. from p. 447)

AGU will acknowledge receipt of all abstracts. Notification of acceptance and scheduling information will be mailed to corresponding authors in early December.

Abstracts

The abstract page is divided into two parts: the abstract itself and the submittal information. Please follow carefully the instructions for each part. Use a carbon ribbon to type the material, and do not exceed the maximum dimensions (11.8 cm by 18 cm) of the abstract. Abstracts that exceed the noted size limitation will be trimmed to conform without regard to content.

The meeting program will be prepared by photographing the abstracts exactly as they are received. Use the model abstract to prepare the final version. Submission of an abstract for an AGU meeting is presumed to carry with it permission for AGU to reproduce the abstract in all editions of *EOS* and in the program and reports relating to the meeting. It is also presumed to permit the free copying of those abstracts. Although *EOS* is a copyrighted journal, authors are not requested to transfer copyright. Copyright, where it exists, will be reserved by the authors.

Submittal Information

Numbers refer to the items in the submittal information block on the sample abstract.

- Title of meeting.
- Identification (abstracts not authored by a member of AGU or of one of the co-sponsoring societies must be sponsored by such a member; this includes invited authors): Type name of society to which any of the authors belong, or if an author is a member, type the name of the society in which the sponsor belongs (indicated by XXXX on the submittal information block) and the sponsor's name.
- Corresponding address: Give complete address and phone number of author to whom all correspondence (acknowledgment, acceptance letters) should be sent. Abbreviate as much as possible.
- Discipline to which abstract is submitted (use the following letter abbreviations): A (Atmospheric Sciences); B (Biological Oceanography); C (Chemical Oceanography); G (Geological Oceanography); O (Ocean Technology); P (Physical Oceanography); S (Acoustical Oceanography); X (Other).

5. Type title of special session (if any) to which submittal is made.

6. Indicate your preference for a particular kind of presentation by one of the following letters: O, oral; P, poster. The chairman may assign you in either of these types of presentation in order to fit his or her program plan.

7. Percent of material previously presented or published, and where.

8. Billing information.

(a) Complete billing address if other than the corresponding address (item 3 above).

(b) If purchase order is to be issued, indicate number upon submittal of abstract.

(c) If a student member is the first author, the student publication rate is applicable. Indicate that the student rate is applicable.

(d) If preprint, enter amount enclosed.

9. Indicate whether paper is G (contributed) or I (invited). If invited, list name of inviter.

Poster Sessions

A large, centrally located meeting room will be set up for poster presentations. Experience from recent AGU meetings and from other scientific societies has shown that a poster presentation, while more demanding of the author, can provide a superb opportunity for comprehensive discussions of research results.

If individual papers are deemed by a program chairman to be suitable for this type of presentation, they may be so assigned.

Presenters of poster papers are reminded that a poster exhibit requires careful preparation. Figures and text will be scrutinized in detail, and authors must be prepared to discuss the contents of their papers in depth. Under these conditions, well-prepared figures and concise, logical text are essential.

Program Committee

Meeting Cochairmen: John R. Apel, Johns Hopkins University, and Richard T. Barber, Duke University

AMS: James J. O'Brien, Florida State University

ASA: Robert S. Winokur, ONR

ASLO: Mary Jane Perry, University of Washington

MTS: Ned A. Ostensio, NOAA

Special Sessions

Warm Core Rings

Air-Sea Interaction in Coastal Regions

Shelf Dynamics: CODE

Optical Dynamics Experiment

Marginal Ice Zone Experiment

California Current

Gulf of Mexico/Caribbean: Biological, Chemical, and Physical Oceanography

Southern Oceans: Dynamics, Biomass

Kuroshio

Arctic Ocean: Dynamics, Biology, Acoustics

Sealwater Spreading Centers

El Niño and Climate Variability

El Chichón, Global Climate, Chemistry

Oceans and Atmospheric Chemistry: CO₂

N₂, Freons

Ocean Heat Transport: Climate, Paleoclimatology

Acoustic Monitoring: Suspended Particulates

Biology

Acoustic Remote Sensing: Fine Structure, Internal Waves, Mesoscale Features

Acoustic Imaging: Seafloor, Precision Bathymetry

Acoustic Tomography

Large-Scale Ocean Observing Systems

SAR Surface Signatures

Ocean Tracers

Radioactive Disposal

Environment and Fisheries Year Class Summary

Zooplankton Behavior

Plankton Growth Rates in Oligotrophic Waters

Below Ground Processes in Wetland Ecosystems

Phytoplankton Responses to Fluctuating Environments

Aquatic Nitrogen Cycles

Interrelation of Optical and Biological Properties

Dynamics of Microaggregates in Oceanic Systems

Organism Growth and Behavior in a Turbulent Fluid

Biology and Physics of the Benthic Boundary Layer

Feeding Ecology of Fishes

Cyanobacteria: What Are They Doing?

IUGG Quadrennial Report Overview

Solar-Planetary Relationships: Aeronomy 1979-1982

Richard S. Stolarski

NASA/Goddard Space Flight Center, Greenbelt, MD 20771

Aeronomy is the study of the physics and chemistry of the upper atmosphere. The upper atmosphere is usually defined as the region of the atmosphere above the tropopause extending upward to the point where electric and magnetic fields dominate the phenomena rather than the atmospheric atoms and molecules. The lower part of this region, from about 10 to 90 kilometers altitude, has become known as the middle atmosphere. An international program called MAP (Middle Atmosphere Program) is now underway to intensively study this region. Three reviews of work in the middle atmosphere appear in this volume covering the composition, dynamics, and electrodynamics. Susan Solomon's paper, "Minor Constituents in the Stratosphere and Mesosphere," documents the continued growth in knowledge concerning the composition of the middle atmosphere, the mechanisms which maintain this composition, and

its possible response to outside influences. Dennis Hartmann's review, "Middle Atmosphere Dynamics," examines the large-scale dynamics and climatology of the middle atmosphere, particularly pointing out the importance of the introduction of transformed Eulerian mean equations for dynamics and transport and the realization of the importance of gravity waves for the momentum budget of the stratosphere. Michael Kelley's review, "Middle Atmosphere Electrodynamics," discusses a variety of new techniques that have been used to obtain "existing and controversial" results including large (several volt/meter) fair weather electric fields in the mesosphere.

Above the middle atmosphere is the region referred to as the thermosphere or ionosphere, depending on which properties of the region are being emphasized. The review of this region is again divided into several papers. Douglas Torr's "Neutral and Ion Composition of the Thermosphere" summarizes the continued advances in the understanding of low solar extreme ultraviolet radiation interactions with and determines the composition and structure of the thermosphere. He emphasizes the significant contributions of the Atmosphere Explorer Satellite series. Raymond Roble, in "Dynamics of the Earth's Thermosphere," puts his emphasis on questions concerning the global circulation, temperature, and compositional structure of this highly variable region. "Ionospheric Electrodynamics and Irregularities" are covered by Arthur Richmond with emphasis on the modeling and data concerning the global electric

circuit. This both the middle atmosphere and the thermosphere are described in three reviews emphasizing different aspects of the physics and chemistry of the respective regions. A further report, "U.S. Contributions to Auroral Aeronomy, 1979-1982" by M. H. Rees, is devoted mainly to the special aspects of the thermosphere which are initiated in the auroral region by particle precipitation. Finally, the "Aeronomy of the Inner Planets" by Toin Cravens and Andrew Nagy covers the recent advances in understanding of the thermospheres of Mars and Venus, providing a summary of the recent Pioneer Venus results.

Contents: IUGG Quadrennial Report
Solar-Planetary Relationships: Aeronomy

U.S. Report to the IUGG, 1979-1982: Solar-Planetary Relationships: Aeronomy, R. S. Stolarski

Dynamics of the Earth's Thermosphere, R. G. Roble

Ionospheric Electrodynamics and Irregularities: A Review of Contributions by U.S. Scientists From 1970 to 1982, A. D. Richmond

U.S. Contributions to Auroral Aeronomy, 1979-1982, M. H. Rees

Neutral and Ion Composition of the Thermosphere, D. G. Torr

Aeronomy of the Inner Planets, T. E. Cravens and A. F. Nagy

Middle Atmospheric Electrodynamics, M. G. Kelley

U.S. National Report to IUGG 1979-1982

EOS is periodically publishing the 12 interviews appearing in the *U.S. National Report to the International Union of Geodesy and Geophysics 1979-1982*. The U.S. National Report is being published by AGU on behalf of the U.S. National Committee in four extra issues of *Reviews of Geophysics and Space Physics* (RGSP). The discipline overview appearing here was published with its associated papers (see Contents list at the end of the overview) in volume 21, number 3, March 1983 of RGSP.

Subscribers to RGSP will automatically receive the four extra RGSP issues containing the U.S. National Report. All four extra issues will have been mailed by July 1983. The four regular issues of RGSP are appearing as usual in February, May, August, and November. Those who do not subscribe to RGSP can still obtain the entire U.S. National Report by entering a subscription to RGSP. In addition, the report of each discipline will automatically be mailed separately to those members of AGU for whom that discipline is their primary AGU section affiliation; this separate distribution is made possible by grants from the Defense Mapping Agency, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and U.S. Geological Survey.

Minor Constituents in the Stratosphere and Mesosphere, S. Solomon
Middle Atmospheric Dynamics, R. L. Hartmann

News

Arctic Air Chemistry: Haze Analysis

The microparticulate (i.e., aerosol) and gas concentrations in Arctic air masses are being assessed currently as a result of a large-scale, multinational cooperative study made this spring. It turns out that many of the ideas about the origin of Arctic haze, industrial pollution, soil particles from the great desert regions of eastern China and Mongolia, and seasonal effects, to name a few, may all be valid. A recent report about the first extended airborne measurements of Arctic haze that were made during March and April of this year stated: "Most of the scientists on board the NOAA plane found the haze to be much denser and more extensive than they anticipated" (*Environ. Sci. Technol.*, June 1983).

The results of these studies will be presented at the third Symposium on Arctic Air Chemistry, to be held in May 1984 at Toronto. Within the myriad character of Arctic air patterns (chemistry, seasons, and climate) can be found the pleasant fact that at times of the year—late spring and summer—the Arctic is free of pollution and haze; the air is pristine and clear. During that period, aerosols and pollutants are scavenged and the atmosphere is clean because of its remoteness from major polluting sources. By late October, however, the Arctic air dries, and air masses containing the emissions from industrial sources far away are transported slowly over the northern polar region.—PAB

and it generated large numbers and types of air chemistry measurements.

The results of these studies will be presented at the third Symposium on Arctic Air Chemistry, to be held in May 1984 at Toronto. Within the myriad character of Arctic air patterns (chemistry, seasons, and climate) can be found the pleasant fact that at times of the year—late spring and summer—the Arctic is free of pollution and haze; the air is pristine and clear. During that period, aerosols and pollutants are scavenged and the atmosphere is clean because of its remoteness from major polluting sources. By late October, however, the Arctic air dries, and air masses containing the emissions from industrial sources far away are transported slowly over the northern polar region.—PAB

Lost Island Found

An abandoned 11-by-5-km kidney-shaped chunk of freshwater ice, used as a research station for 25 years, was rediscovered after the National Oceanic and Atmospheric Administration (NOAA) lost track of the island for 6 months. The recent find may foreshadow another loss, however: The island is drifting through the Greenland Sea and into the North Atlantic where it should melt within several months and dump its cargo of oil drums, equipment, and a wrecked plane into the ocean.

Known as Fletcher's Ice Island—after Joseph O. Fletcher, a member of the first team of researchers to inhabit the island and a recently retired NOAA climate researcher—the ice chunk has already melted to a third of its original 49 m thickness. A pilot flying over the area to measure annual pollution buildup in the Arctic located the drifting island 242 km from the North Pole near the International Date Line.

Identified by Fletcher as a fragment of the Ellesmere Island ice shelf, the island was the home for a number of Air Force, Navy, and NOAA scientific teams that provided weather reports and conducted experiments. Before satellites superseded the research and forecasting functions of the teams on Fletcher Island, the station also was a valuable site for observing oceanic and atmospheric circulation. First occupied in 1952, the island was abandoned in the mid 1970s.

In addition to its historical significance to scientific research, the site gained notoriety when a man on the island lost his life in an argument over a bottle of wine.

New Climate Center

An Experimental Climate Forecast Center has been established at the NASA Goddard Laboratory for Atmospheric Sciences (GLAS) by the National Oceanic and Atmospheric Administration's (NOAA) National Climate Program Office. NASA's Goddard Laboratory will provide the computing facilities necessary to process the vast amount of data used in complex numerical climate modeling.

As the second of the centers established under the National Climate Program Act of 1978, the Experimental Climate Forecast Center will investigate climate predictability theory and forecasting techniques by using numerical methods in dynamic models of the earth's ocean and atmosphere system. The first center, at the Scripps Institution of Oceanography, concentrates on statistically based methods. The principal interest of both centers is the potential for forecasting characteristics of seasonal temperature and precipitation. The director of the new center is William Hahn; he also will continue as head of the global modeling and simulation branch at GLAS.

NOAA's National Climate Program supports research on improving forecasts of next season's and perhaps next year's weather to aid planning for crop fertilization and irrigation schedules, geographical distribution of heating fuel, and maintenance of urban fresh water supplies.—BTR

NASA FY1984

The White House budget request for the National Aeronautics and Space Administration (NASA) for fiscal year 1984 contains a number of continuing problems for outside investigators in universities and in the private sector. Nonetheless, the budget climate for NASA seems to be improving. (For more information on the budget for FY1984, see *EOS*, February 15, 1983, p. 55, and May 17, 1983, p. 378.)

Several new program starts are responsible for the feeling of optimism being sensed in many sectors of the scientific community. These include the Venus Radar Mapper, a shuttle-borne satellite to study the earth's upper atmosphere (the tether could be 100 km in length), and the EUVE experiment (Extreme Ultraviolet Explorer).

The problems that remain in the budget are unfortunately rather focused on the geophysics academic community. For example, research and analysis funds are reduced in the FY1984 request to about what they were in the FY1983 request because Congress restored the funds cut last year. This year, the battle is going on again in both Houses, and at this point it appears as though the cut funds may be replaced again, particularly if Congress is supported by the scientific community as it was last year.

In FY1985, the research and analysis appropriation was \$50.3 million. This fiscal year it is down to \$45.5 million, but by mid-August the new appropriation may restore the cut. The budget request overall is set by the Office of Budget and Management at \$7.106 billion, which is an increase of \$755 million.

The space science portion of NASA's budget has been boosted significantly for FY1984 by about 14%. The Gamma Ray Observatory is back on a schedule with a launch date of 1985. The Venus Radar Mapper will fly also in 1985, to be launched by the shuttle-Centaur upperstage. The Galileo mission is to

be launched by Centaur in 1986 and will arrive at Jupiter in 1988.

NASA will not send its half of the two-satellite experiment in the 1986 launch of the International Solar Polar mission. Funds are being aimed at supporting the remaining single spacecraft of the European Space Agency.—PMB

Hess Centennial

June 24 marked the 100th birthday of Victor F. Hess, the discoverer of cosmic radiation. The Austrian-born scientist received the Nobel Prize in physics in 1936 with Carl Anderson of the California Institute of Technology, who discovered the positron. When he died in 1964, Hess had more than 150 articles and publications to his credit.

In 1910, while a lecturer at the University of Vienna, Hess launched an unusual series of experiments to measure the conductivity of air. He made 10 balloon ascents, half of these at night. On the basis of these experiments, he concluded that "radiation of very high penetrating power enters our atmosphere from above." One ascent made during a solar eclipse proved that the sun could not be the main source of cosmic rays.

Hess made his first trip to the United States in 1921. Under his supervision, a research laboratory, the United States Radium Corporation, was built in New Jersey; he served for 2 years as the corporation's director and chief physicist.

Hess then returned to Austria to the University of Graz, where he later became dean of the faculty. He accepted a position at the University of Innsbruck in 1931 and established a laboratory for the observation of cosmic radiation there. Six years later he returned to Graz. In 1938, after Hitler's Germany annexed Austria, Hess fled with his wife, who was Jewish, to Switzerland. While in Geneva, Hess was offered a full professorship by Purdue University. He accepted and moved back to the United States. Hess retired from Purdue in 1958.



Victor F. Hess

MOVING?

Give AGU your new address!

Please allow up to 6 weeks for change to be effected. Only one notice needed for AGU membership record and all AGU subscriptions. Return this panel, with label, to

Please print or type new address

American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

or call toll free 800-424-2468 or, in the Washington, D.C. area 462-6903.

New phone numbers (will be published in Membership Directory)

Office ()
Home ()

The VGP News



Editor: Bruce Doe, 11721 Dry River Court, Reston, VA 22091 (telephone 703-860-8170, after 5:30 p.m.).

Sigurdur Thorarinsson 1911-1983



Charles A. Wood

In March 1875 a number of farms were abandoned in eastern Iceland as a consequence of the great eruption of Askja volcano. The abandonment of one farm, however, had to be delayed as the family was expecting a child. In the spring a son was born. He was Thorarin, the father of Sigurdur Thorarinsson. This incident is merely one example of the dynamic interaction between man and nature which is so typical of Iceland. Here the geological mill, fueled by vigorous volcanism, glaciers, and swift rivers, grinds faster than elsewhere on earth. Here the existence of a small nation is continually responding and adjusting to the environmental pressures generated by rapid and sometimes catastrophic earth processes.

Sigurdur Thorarinsson died in Reykjavik on February 9, 1983, at the age of 71, following a brief illness. Born on January 8, 1912, he was the leading Icelandic earth scientist of the 20th century and acquired international renown for his research in volcanology. The list of accomplishments of this remarkably versatile man is indeed impressive. He pioneered the development of tephrochronology as a branch of earth science, first as a tool in archaeological research and later as a key in the volcanic history of Iceland. The fruits of this research included a monograph on the eruptions of Hekla in historical times and led to the important discovery of a regular relationship between the length of repose period and the silica content of Hekla's magmas.

Sigurdur witnessed or studied all volcanic eruptions in Iceland since 1934. Probably no other scientist has accumulated comparable field experience on active volcanoes. His accounts of the birth and growth of the volcanic island of Surtsey are classics in volcanological research and clarified our understanding of the role of seawater in hyaloclastite formation, the characteristics of base surge activity, and the evolution of table mountains. He immediately embraced the concepts of plate tectonics and applied them to interpretation of the structure of Iceland as early as 1965. He also made important advances in glaciology and contributed to the understanding of the relationship between geothermal activity in subglacial volcanoes and periodic jokulhups or glacier bursts. His works in the fields of geomorphology and soil erosion further emphasized the breadth of his interests.

Sigurdur maintained a remarkable productivity through the years, and published well over 200 papers and books. At the time of his

death Sigurdur was preparing manuscripts on the 1783 fissure eruption of the Laki crater-rim and its atmospheric effects on the northern hemisphere. Other works in progress included the volcanic history of Iceland and the long-awaited Icelandic volume of the *Catalogue of Active Volcanoes of the World*. These compilations represent a life-time labor of love but were continually being updated to include new research and new eruptions. It is hoped these works will be published posthumously.

Sigurdur Thormann studied in the University of Copenhagen and the University of Stockholm, where he completed a classic doctoral dissertation in 1944 on the tephrochronology of Iceland. He returned to Iceland and became director of the Geology Department of the Museum of Natural History in 1947 and the first professor of Geology in the University of Iceland in 1968.

Another side of Sigurdur's personality, not generally known to his foreign colleagues, was his work as a poet and songwriter. He wrote hundreds of witty poems, which have become part of the Icelandic folksong tradition. His poetry, good humor, and inexhaustible energy in informing the general public about geological processes made him Iceland's favorite son. Sigurdur was never a controversial figure; his innovative research was always solid and his sense of humor was always there. He was fair and unselfish and generously shared his ideas with colleagues, who always held him in highest regard. His death is a great loss to the science of volcanology.

This tribute was written by Haraldur Sigurdsson of the Graduate School of Oceanography, University of Rhode Island, Kingston, RI 02881.

Welcome to The VGP News

Scope of the Section

Beginning with this issue of *Eos*, the Volcanology, Geochemistry, and Petrology Section of AGU will publish brief and timely scientific reports, highlights of conferences, statements of opinion, section news, and other topical information approximately every 3 months in a new section of *Eos* called "The VGP News."

Material for The VGP News will be handled by Eos Editor Bruce R. Doe, VGP Section President. J. V. Smith has appointed the following editorial group to work with Doe:

Peter W. Lipman, VGP Secretary, U.S. Geological Survey, MS 915, Federal Center, Denver, CO 80225 (telephone: 303-234-2901)

Charles A. Wood, SN4-NASA Johnson Space Center, Houston, TX 77058 (telephone: 713-483-3816)

William P. Leeman, Department of Geology, Rice University, Houston, TX 77001 (telephone: 713-527-4880)

Joseph R. Smith, 156 Hedra Loop, Los Alamos, NM 87544 (telephone: 505-672-1925)

Peter W. Lipman
Secretary, VGP

VGP Opportunities

It is a great pleasure to introduce this first edition of The VGP News. I have enjoyed greatly the reports from the Oceanography section and was delighted to find that Brent Dalrymple and Peter Lipman were equally enthusiastic in starting a VGP equivalent. Chuck Wood has provided a very useful service with his Volcano News, and the plus Bill Leeman and Joe Smith have the enthusiasm and general knowledge to put together valuable news items. But they will need the help of other members of the section in their work.

Our section faces major problems in capitalizing on the remarkable growth of knowledge and techniques. We need to integrate the laboratory and field aspects of our science. The new techniques, such as high-energy mass spectrometry and synchrotron-based experiments, will put further pressure on funding.

Our section could provide a useful public service by providing reliable information on geological hazards along with advice on the consequences of various social and political choices. We could also discuss the problems of the fractionation of the earth sciences into so many subgroups and possible ways of providing increased cooperation between them (e.g., the various geochemical-based societies).

On behalf of the whole section, I wish the editors and secretary all the best in this venture and thank them for their labors.

Joseph V. Smith
President, VGP

News & Announcements

New Crater in Costa Rica

On April 9, 1983, we discovered a new explosion crater buried in the thick rain forest that covers the flanks of Arenal volcano in Costa Rica.

The previously undetected crater, which we named Crater 1, is located between the twin volcanic systems Arenal-Chato at 84°41'53"W and 10°27'42"N (Figure 1). It resulted from a phreatic explosion occurring probably during the 1918 explosive phase, in which three other well-known main craters (A, B, and C) were opened along a fracture on the western side of the Arenal Volcano. Crater 1 has formed at the physical discontinuity that existed at the boundary of Arenal's

lava-flow that was created during the 1500 eruption cycle. The explosion, a 100-m-diameter blast oriented 115° from the south, originated at a depth of approximately 50 m, leaving a circular crater 25 m wide and 15 m deep with an axis dipping 15° to the east. The crater is made up of mudstone, lava blocks and lapilli and is now covered by thick ferns.

Crater 1 substantiates the existence of a deep, SE-NW-trending fracture system in which the twin volcanoes have evolved. It gives important parameters to locating zones of weakness in which future explosive activity may take place.

This news item was contributed by Andrea J. Gila, Centro de Investigaciones Geológicas, Universidad de Costa Rica, Ciudad Universitaria, "Rector Fournier," Costa Rica, and Clark Moore, AGU, Department of Geology, Beloit College, Beloit, WI 53571.

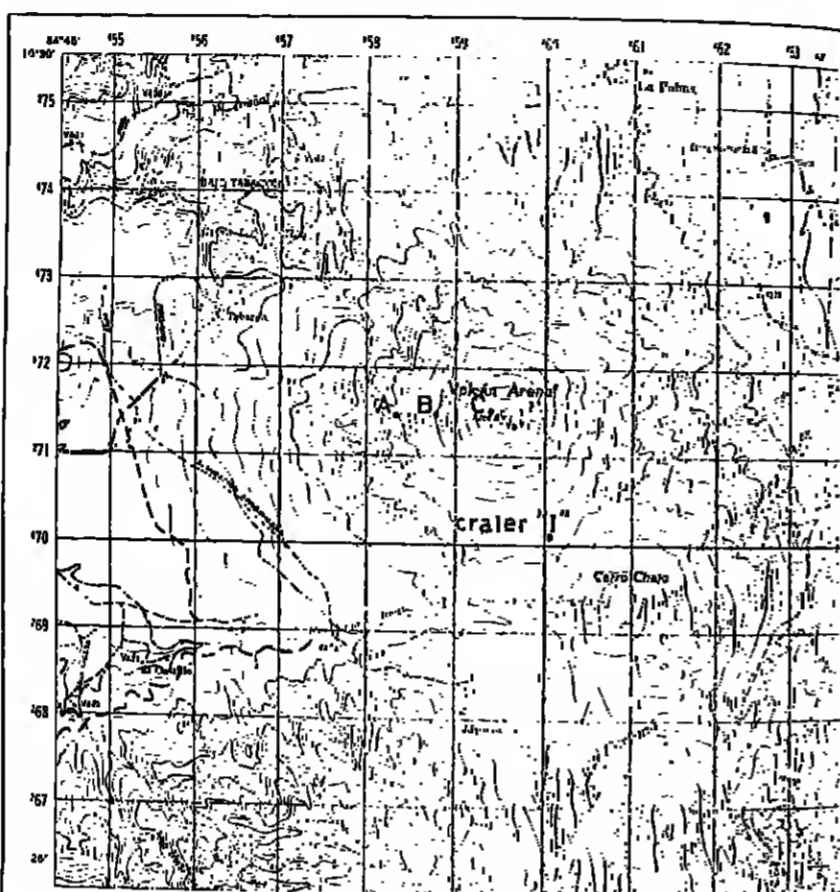


Fig. 1. Topographic map of Arenal-Chato twin volcanic system showing the location of Crater 1. Craters A, B, and C, formed during 1918 explosive phase, are also shown. Map from the Instituto Geográfico Nacional, San José, Costa Rica. Scale 1:50,000.

Irvine Receives VGP Award



T. N. Irvine

Citation

Textbooks of not so long ago typically presented the study of stratiform igneous intrusions as a simple and straightforward exercise in nature's petrology laboratory. The fractional crystallization products of mafic magmas were presumed to accumulate sequentially, largely in response to gravity. Those familiar with the literature of the past several years are aware, however, that the textbooks of the next generation will conclude that this model, if not actually wrong, is at best a gross oversimplification. Why this apparent fall from grace of such a seemingly useful concept?

One reason is that the number of geologists willing and able to visit the cold and lonely places where such bodies in the northern hemisphere invariably occur has grown. Consequently, the amount of geological information on the structure and composition of such bodies also has grown. But merely increasing the size of a cottage industry need not necessarily alter the nature of its product. So too the new directions in the study of layered intrusions are the result of far more than just a

growth in the amount of available data. It is primarily the result of a few creative people seeking new observations, combining them with theory and experiment, and offering new insights into the meaning of these observations.

The recipient of the 1983 VGP Award, T. N. Irvine, is a prominent example of such a person, and he is specifically honored for his studies of the Muskox intrusion in northern Canada. An appreciation of the work he has done there and the insights recovered from his studies may be gotten from his paper in the volume on *Physics of Magmatic Processes* (R. B. Hargraves, Ed., Princeton University Press, 1980). But any one of a number of his earlier papers on geological observations, theory, and laboratory experiments relating to the evolution of layered intrusions would do him credit in this regard. It is difficult to avoid the suspicion that Irvine has a secret phone booth into which he steps to shed his mind-numbing exterior before writing papers of such intellectual force.

So what has Irvine done to clear our vision with regard to the meaning of layered intrusions? In general terms he has provided persuasive evidence that much more than crystallization and gravitational crystal settling occur in the Muskox and other intrusions. The importance of repeated injections of magma into a fractionating chamber, the mobilization of country rock, the mixing of fresh, fractionated, and contaminated magmas, the percolation of intercumulus liquids, the action of turbidity currents, and the operation of double-diffusive convection have all been recognized through Irvine's careful work. Although, as a consequence, layered intrusions can no longer be viewed as the result of simple crystal fractionation and settling, they have actually become much more interesting petrological showcases for a rich variety of geophysical processes. For Neil Irvine's contributions to this important and fundamental transformation in petrologic thinking, I am pleased to present him with the 1983 VGP Award.

Joseph V. Smith
President, VGP

Acceptance

I am most pleased to be honored with this award and to know that my work on layered intrusions is appreciated to such an extent. This work has been going on now for more

than 25 years, so I presume that a considerable cumulative effect is reflected here. Over such a long time, one benefits through associations with many people, and I will take this occasion to mention those who have helped me most.

My list has a strong Canadian flavor, and it begins with Bruce Wilson at the University of Manitoba, where I was an undergraduate. When I think back, I realize that my career was practically determined by two or three of his lectures in which he described some of his own very perceptive work on layered intrusions and their ore deposits. Those lectures attracted my interest in the rocks that have since become my principal research subjects. Bruce also directed me to Caltech, which was the next step on my way.

Shortly after I arrived at Caltech, I learned that Jim Noble, who was then Professor of Economic Geology, had charge of a project in which he hired students to work on intramafic rocks in southeastern Alaska. This appealed to the interest that Wilson had raised, so when the time came to find a job for the following summer, I sought Jim out. He signed me up to go to the Muskox, where, as it turned out, we found the world's most beautifully layered intramafic rocks. From that time on I was hooked! Most people who know southeastern Alaska shudder at all the rainy weather, and Duke Island itself is a rather swampy place. But to me at the time, it was the most exciting place on earth. I literally thrived at the mapping that unraveled the complicated layering structures, multiple intrusions, and magmatic replacement bodies. During this work and through to its publication some years later, Jim Noble gave me patient support and encouragement, and I am greatly indebted to him.

EOS

Transactions, American Geophysical Union

The Weekly Newspaper of Geophysics

For full articles and meeting reports send one copy of the double-spaced manuscript to Eos, c/o AGU at the address below and three copies to one of the editors, or send all four copies to Eos. For news items, send two copies of the double-spaced manuscript to Eos.

Editor-in-Chief: A. F. Spillhaus, Jr., Editors: Marcel Ackerman, Mary P. Anderson, Peter M. Bell (News), Bruce Doe, Robert H. Eather (History), Clyde C. Good, Arnold L. Gordon, Louis J. Lantieri, Robert A. Philpotts (Managing Editor), George F. P. (Editorial Assistant), Kathleen M. Lafferty (News Writer), Barbara T. Kellman (News Editor), Barbara J. Lantieri (Production Staff), James H. Hildebrand, Sue Song Kim, Patricia Lichstein, Lisa Lichtenstein.

Officers of the Union

James A. Van Allen, President; Charles L. Drake, President-Elect; Leslie H. Merrell, General Secretary; Carl Kistler, Foreign Secretary; A. F. Spillhaus, Jr., Executive Director; Walter E. Smith, Executive Director Emeritus.

For advertising information, contact Robin E. Lide, advertising coordinator, 202-462-6013. Copyright 1983 by the American Geophysical Union. Material in this issue may be photocopied by individual scientists for research or classroom use. Permission is also granted to use short quotes and figures and tables for publication in scientific books and journals. For permission for any other uses, contact the AGU Publications Office.

Views expressed in this publication do not necessarily reflect official positions of the American Geophysical Union unless expressly stated.

Subscription price to members is included in annual dues (\$20.00 per year). Information on institutional subscriptions is available on request. Second-class postage paid at Washington, D. C., and at additional mailing offices. *Eos*, Transactions, American Geophysical Union (ISSN 0098-5241) is published weekly by

American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D. C. 20009

Cover. A view of the 2.3-km-diameter Akutan Volcano caldera of Akutan Island, Alaska. Such a view, looking south on January 16, 1983, is rare owing to the normally poor Aleutian weather conditions. Note the recent ash fall on the snow just to the left of the steaming, circular crater cone. A small ash eruption occurred from this cone in December 1982. In September 1978, a fairly large ash eruption occurred in which andesitic lavas flowed from the base of the steaming cone over a large part of the caldera floor, through the northern breach in the caldera wall, and then down the northern slope of the volcano to within 1 km of the coast. During recent investigations, organic soils were found directly beneath parts of the large pyroclastic flow and air-fall deposits that resulted from the caldera-forming event. The carbon 14 age determined for this soil (three dates only) suggests that the Akutan caldera may have formed about 5,000 yr B.P. (Photo courtesy of John W. Reed, State of Alaska Division of Geological and Geophysical Surveys, Anchorage, AK 99510.)

After graduation I worked for a summer with the Geological Survey of Canada on a helicopter survey in the Northwest Territories. On that survey we geologically mapped an area of approximately 60,000 square miles. This was a marvelous experience in itself, in part because the country was virtually unknown and in part because I made a transition from mapping at 50 feet to the inch at some places on Duke Island in mapping at 8 miles to the inch from a helicopter. There is nothing quite like that in broader one's horizons! The more immediate significance of the survey, however, is that the area included a large, layered intrusion that had only just been discovered. That body is now called the Muskox intrusion. I saw Muskox only briefly that summer, but I was impressed that it was totally different from the Duke Island rocks, yet every bit as intriguing. I was delighted, therefore, several years later when the opportunity came for me to work on it full time.

When I joined the Muskox project at the Geological Survey in Ottawa, Charlie Smith was leader, and Chris Findlay, though still a student, was deeply involved. Charlie had predicted a map of the intrusion that ranks with the best of its kind, and he and Chris were prime forces in promoting and carrying out a major drilling program to obtain continuous samples. Charlie, Chris, and many others who contributed, have long ago gone on to other endeavors. I am very much their beneficiary, and whatever success I have had with Muskox is largely owing to their excellent groundwork.

Since I moved to the Geophysical Laboratory, I have continued to work on Muskox, but my director, Hatten Yorler, has made it possible for me to also explore many other intrusions. I have been back to Duke Island; I have worked on Axelgord in British Columbia; Skeragard in Greenland; Stillwater in Montana; and Bushveld in South Africa. I have visited Rhum in Scotland and the Duluth Complex in Minnesota. The opportunity to compare all these bodies has been wonderful, all the more so because of Hat's enthusiastic support.

In the past few years, Skeragard and Stillwater have been receiving most of my attention. At Skeragard, I've gone back to detailed mapping to determine layering structures and I have enjoyed the splendid scenery and exciting trips. My thanks here go to Alexander McBirney. Mac encouraged me to go to Greenland in the first place, and more than anyone he opened my eyes to the potential importance of double-diffusive convection as an igneous process. At Stillwater the feature of interest has been a platiniferous zone. This study, which has led deeply into double-diffusive convection and magma mixing, has been done in collaboration with three geologists with the Johns-Manville Corporation—Stan Tiedt, Doug Keith, and Don Schissel—and I am most grateful to them and their employers for the opportunity.

To round out my list, I would also mention Dick Jahus, who taught me useful mapping methods; Gerry Wasserburg and Sam Epstein, who impressed me with the value of applying physics and chemistry to geological problems; Hugh Taylor, with whom I have had countless discussions of layered intrusions; and Gabriel, who gave me much help in work that I have done in British Columbia.

Gerhard von Gruenewaldt, who arranged a stimulating 3-month visit for me to the Bushveld Complex; and last but not least, my wife, Lorna, whose wisdom and spirit have been major factors in my career and who, together with our children, Michael and Kerri, gives my life its balance.

I have had many pleasures in working with layered intrusions, but I will admit also to the feeling that with all my opportunities I should have accomplished more. This award is very much a reminder in that respect as well, but if it helps to keep me going (as it should), then it will be all the more to my good. Thank you very much.

T. N. Irvine

Meetings

El Chichón Data

The March-April 1982 eruptions of El Chichón have produced the largest atmospheric impact of any eruption since at least Krakatau in 1883. The main geological variable that is responsible is the unusually high S content of the erupted magma. The ultimate source of this sulfur is still unresolved.

Some highlights of the scientific papers dealing with the eruptions and presented at the AGU Fall Meeting in San Francisco, December 10-11, are discussed below. (The abstracts are in *Eos*, November 9, 1982, pp. 807-808, 900-902, and 1126-1127.)

Wendell Dufield et al. described the geological setting. Although scanty information is available, El Chichón was an inconspicuous, domes-and-stratovolcanoes with active surface geothermal activity before the eruption. At least two prehistoric eruptions occurred in the last 1250 years. The volcano is built on volcanic and sedimentary rocks of Tertiary age which overlie Cretaceous sediments. A drill hole near the volcano into the Cretaceous section has penetrated evaporite beds. Dufield et al. suggested that these rocks may have influenced the magmatic volatile fraction of the 1982 magma.

Servando de la Cruz described ground observations of the eruption. The 1982 activity consisted of three main eruptions: March 28 at 2332 local time, April 3 at 1935, and April 4 at 0533. The first eruption destroyed part of the summit dome, produced an eruption column 17 km high, lasted about 5 h, and caused a widespread ash fall over southern Mexico, Belize, and northern Guatemala. The second phase of the eruption was documented in a spectacular sequence of night-time photographs which show the growth of the incandescent eruption column and volcanic lightning. A pyroclastic surge occurred in the first 10 minutes of this eruption. Cruz's pictures show the collapse of the eruption column and the movement of a pyroclastic flow down one of the river valleys to San Francisco Leon. The flow from, brightly incandescent and apparently turbulent, was noisy in the photographs.

The third eruption produced an airfall deposit only from a similar magnitude eruption column. The three eruptions were similar in the volume of material erupted. Various speakers estimated the total volume erupted at 0.4-0.6 km³ of dense rock.

As a result of the eruptions, there is now a

Antarctic Research Series Vol. 33

Dry Valley Drilling Project

L.D. McClintock, editor

Core analysis is the major emphasis of DVDP. The wealth of scientific data from these (first) rock drillings make a vital contribution to understanding the geologic and glacial history of the McMurdo sound area. The vast ice-free valleys of Antarctica virtually unexplored, became the research center for a cooperative international venture between the U.S., New Zealand, and Japan. DVDP chronicles the final reports of the U.S. scientists. The very significant conclusions in this volume will be the basis for the next generation of studies and projects to be carried out in Antarctica.

480 pages \$36.00
Hardbound Less 30% AGU
Illustrated

Orders under \$50 must be prepaid
American Geophysical Union
2000 Florida Ave., N.W.
Washington, D.C. 20009
800-424-2488 (202) 462-6903
Toll free In the Washington area

crater occupying the site of the old dome, pyroclastic surge (or low aspect-ratio ignimbrite) deposits all around the crater, and pyroclastic flow deposits down river channels for several kilometers. These disrupted drainages and caused many secondary lahars.

A network of seismographs was operating in a six-station teleseismic array for 2 years prior to the 1982 eruption. The data, studied retrospectively due to the remoteness of the station, and reported by S. K. Singh et al., show a seismic build-up which began weeks before the eruption, and increased sharply on March 1. The high seismicity lasted through March 28 but stopped completely 2 h before the first eruption. The depths of one type of earthquake, thought to be associated with the magma-groundwater contact, was about 5 km. There were also a significant number of quakes at 15-20 km depth. This suggested to de la Cruz that there may be a dual magma storage system.

J. Varekamp and J. Lahr in separate papers reported on the extent, petrology, chemistry, and mineralogy of the ash. The ash is fine-grained (85% < 1 mm), highly dispersed, and has the characteristics of a plinian eruption. It is a mixture of ash and fine-grained material to phreatic plinian fall deposit with three fall units, assumed to correlate with the three eruptions. The ash fell out of the atmosphere partly as aggregates, which Varekamp proposed were held together with sulfuric acid. The magma was an alkali-rich trachyandesite with 56% SiO₂, 2.8% K₂O and an extremely high S content (0.5-1.0% S). This S concentration is more than 10 times that "expected" for a magma with the composition of El Chichón's. It is also about 50-100 times greater than the 1980 Mount St. Helens dacite. Andesite, hornblende, augite, magnetite, sphene, and apatite are phenocryst minerals, but compelling evidence was given by Lahr to

(cont. on p. 452)

Maurice Ewing Series: Volume 4 ISBN: 0-87590-403-3

Earthquake Prediction

An International Review (1981)

David W. Simpson and Paul G. Richards, editors

The scope of the earthquake observation network has rapidly increased. Presented here is research from scientists worldwide exploring geodetic, seismic, geomagnetic, geoelectric and geochemical observations with particular attention to crustal deformation.

- Seismicity Patterns
- Geological and Seismological Evidence for Recurrence Times Along Major Faults
- Short, Long and Intermediate-Term Precursors to Earthquakes: Seismic and Non-Seismic
- Fundamental Studies, Laboratory Investigations and Models
- Reviews of the National Programs of Japan, China and the USA

51 papers 688 p.p. Illustrated
List price \$38.00 less 30% discount to AGU Members

Order from:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, DC 20009

Prepayment by check, credit card or money order required for orders under \$50.

or call toll free 800-424-2488 (in the Washington area 462-6903)

ISSN: 0197-8348

The Maurice Ewing Series covers convergent tectonics in a broad spectrum of geophysical and petrologic studies. These volumes are intended to give a survey of current studies in present and past areas of subduction by utilizing multichannel seismic-reflection profiles, heat flow measurements, hypocenter locations, and volcanic rock compositions to bring out the processes and products of plate consumption.

Other Titles

Deep Drilling Results in the Atlantic Ocean: Continental Margins and Paleoenvironment (1979), edited by M. Talwani, W. Hay, and W.B. Ryan, 439 p.p., ISBN: 0-87590-402-5 List price \$23.00.

Deep Drilling Results in the Atlantic Ocean: Ocean Crust (1979), edited by M. Talwani, C.G. Harrison, and D.E. Hayes, 448 p.p., ISBN: 0-87590-401-7 List price \$23.00.

Island Arcs, Deep Sea Trenches, and Back-Arc Basins (1979), edited by M. Talwani and W.C. Pitman, 480 p.p., ISBN: 0-87590-400-9 List price \$23.00.

(cont. from p. 451)

show that 1% volume anhydrite microphenocrysts observed in these rocks was also in equilibrium with the magma.

Initial isotopic data on S and D in the anhydrite obtained by R. Rye suggest that the enclaves below the volcano were not the source of the anhydrite. Rye estimates the magma temperature was about 800°C before eruption and that it contained 4-5% H₂O and 2.5% S.

J. Hoffer presented data showing chemical composition of the fallout varied with distance from the volcano in a manner consistent with atmospheric fractionation.

S. Self emphasized the point that explosivity of an eruption is a poor index of atmospheric impact, using examples from recent history. He suggested that modest-sized, explosive andesitic eruptions, similar to the El Chichón event except in the extreme S content, might be the most important cause of stratospheric optical depth perturbations. If andesitic eruptions can be shown to be typically S rich, this conclusion would be strengthened.

The atmospheric scientists presented basic data on the stratospheric effects of the eruption. There were many measurements documenting a 25-35% decrease in solar radiation at the earth's surface due to the El Chichón stratospheric particles. The Manna Loa Observatory group reports that this is the largest decrease in atmospheric transmission in the 24-year record there.

A. E. Strong (NOAA-NES) showed that sea surface temperatures over a broad area of the equatorial Pacific were rising at an abnormal rate since the eruptions. The effects on North American weather may be to alter the storm tracks and result in an unusual, but not necessarily colder, winter in North America. A. J. Krueger (NASA-GSFC) showed that SO₂ from El Chichón in the stratosphere has 7 Total Ozone Mapping Spectrometer (TOMS). The interference wiped out the ozone experiment, but allowed the total mass of SO₂ released to the stratosphere to be estimated at 3.3 x 10¹² g. This is 10-15 times the mass estimated by different methods for Mount St. Helens.

This meeting report was contributed by W. I. Rine, Department of Geology, Michigan Technological University, Houghton, MI 49931.

Opinion

Forecasts and Predictions

In recent volcanologic literature, the terms forecast and prediction have generally been considered synonymous. *Wadge and Guest* (1981), however, in assessing the possibility that Mount Etna would erupt before May 1982, stated that "these are not predictions of specific events but general forecasts... based on the behavior of the volcano during the past seven years." *Lockwood et al.* (1979) used the term forecast in anticipating an eruption of Mauna Loa before the summer of 1978 on the basis of historical records. In contrast, *Wood and Whitford-Stark* (1982) used the terms forecast and prediction synonymously when they anticipated an eruption of Kilauea before the end of May 1982 by projecting records from 1975 to the end of 1981; in terms defined here, this statement was a forecast. The fact that all three of these forecasts proved incorrect indicates the relative uncertainty of simply projecting past records and it suggests the desirability of distinguishing, whenever possible, such general statements from more specific predictions based on repeated measurements of changing phenomena on a short time scale.

Three types of written public statements about volcanic activity at Mount St. Helens are issued by scientists at the Cascades Volcano Observatory of the U.S. Geological Survey and at the Geophysics Program of the University of Washington:

• A "factual statement" describes current conditions but does not anticipate future events; such statements are revised when warranted to keep the public and government informed of new developments.

• A "forecast" is a comparatively nonspecific statement about activity expected to occur weeks to decades in advance, issued continuously without data from repeated monitoring, and based on a projection of geologic, geophysical, or geochemical records. Another kind of forecast uses monitoring data whose implications are not well understood. Forecasts aid particularly in land use planning and in the development of emergency response plans.

• A "prediction" is a comparatively specific statement giving place, time, nature, and—ideally—size of an impending eruption. The likelihood of an eruption should also be stated, but such a statement is difficult to quantify.

Predictions are generally based on measurements of relatively short-term changes in longstanding patterns of activity. Predictions may evolve from forecasts and should become increasingly more specific as the eruption nears. At Mount St. Helens, a prediction

is issued a few hours to a few weeks before an eruption—any time there is a relatively clear view of future activity as judged from current similarities with past precursory patterns and from interpretations of the active volcanic processes. Predictions reduce risk to life and property and provide a public test of scientific hypotheses about volcanic processes. Stratigraphic studies led to a 1975 forecast of renewed activity at Mount St. Helens "perhaps before the end of this century" (*Crandell et al.*, 1975). On the basis of seismic, geodetic, and geologic data, forecasts for an eruption (and landslides) in the near future were issued in March and April 1980 before the catastrophic eruption on May 18, 1980. Forecasts in March and August 1981 anticipated dominantly nonexplosive behavior over the next months unless some reversal in geophysical or geochemical indicators occurred; these forecasts remain in effect.

Correct predictions were made of all 13 eruptions at Mount St. Helens from June 1980 to the end of 1982 on the basis of integrated geophysical, geochemical, and geologic monitoring. Predictions several days to 3 weeks before eruptions were based largely on patterns and rates of ground deformation of the crater floor and lava dome; predictions within about 3 days of eruptions depended chiefly on rates of cumulative seismic-energy release and increased numbers of shallow, volcanic earthquakes. Predictions in February and March 1983 were not as successful, owing in large part to poor weather, which curtailed most monitoring, and perhaps to subtle changes in behavior of the volcano.

Subdividing the broad category of anticipatory statements into relatively nonspecific forecasts and relatively specific predictions may have general applicability in volcanology. Volcanologists commonly are called upon to make statements about the future that are based either on projections of geologic or geophysical records or on insufficient or poorly understood data. Such statements can probably be distinguished from the statement, on adequate, up-to-date data on changing conditions at a volcano; such a distinction is scientifically honest and can help public authorities in their evaluation of the statement. There will always be gray areas; in such instances, forecasts rather than predictions should probably be made. In many cases, however, the distinctions are relatively well defined, and the procedure used at Mount St. Helens can be considered.

References

- Crandell, D. R., D. R. Mullineaux, and M. Rubin, Mount St. Helens: Recent and future behavior. *Science*, 187, 438-441, 1975.
- Lockwood, J. P., R. V. Koyanagi, R. J. Tilling, R. T. Holcomb, and D. W. Peterson, Mauna Loa threatening. *Geotitles*, pp. 12-15, June 1976.
- Wadge, G., and J. E. Guest, Steady-state magma discharge at Etna 1971-81. *Nature*, 294, 548-550, 1981.
- Wood, C. A., and J. L. Whitford-Stark, Eruption forecast for Kilauea caldera. *Eos*, 63, 805, 1982.

David A. Johnston, *Cascades Volcano Observatory, U.S. Geological Survey Vancouver, WA 98661*

Kilauea Revisited

"Predictions" of imminent volcanic eruptions are more successful than are "forecasts" of impending activity if we use the terminology defined by Swanson in the accompanying article. The implication is that, despite occasional intervals of periodically recurring eruptions, the long term (months to years) activity of volcanoes is stochastic. Once magma reaches the surface, however, and initiates measurable phenomena (harmonic tremor, inflation, increased fuming, etc.), a volcano appears to be locked into a nonreversible process leading to an eruption weeks to hours hence. Each type of forecasting is valuable, and USGS volcanologists have demonstrated that the basic monitoring and prediction techniques developed for effusive eruptions in Hawaii are transferable to explosive activity in the Cascades. But longer term forecasts, as pointed out by Swanson, are still largely unreliable.

Nonetheless, we believe that forecasts should continue to be made and published for two reasons. First, the forecasts may be correct, providing a longer time for planning of monitoring activities, evacuation plans, etc. Responsible forecasts also serve to increase awareness of volcanic hazards among local authorities, so that when eruptions do come, there has been at least psychological warning. Second, a forecast is based upon observed patterns of activity of a volcano and thus is also an attempt to describe and understand eruption processes. Faulty forecasts have one advantage over erroneous predictions: The former do not have the immediate social and political consequences of the latter (see *Bascock*, 1978, and numerous replies).

Our forecast of an eruption at Kilauea caldera before the end of May 1982 was wrong. November 1981 and continued monitoring by Icelandic scientists reveals no evidence for an impending eruption. We could attempt to neutralize our forecast failure by any or all of the following arguments:

- (1) Kilauea failed to maintain its previous fire pattern of activity.
 - (2) Inflation shifted to new areas immediately prior to our analysis, perhaps diverting magma supply processes and rates.
 - (3) Volcanoes do not erupt forever; it had to stop some time.
- All of the above are true; we did not make a mistake in our analysis or forecast—we simply had the bad luck to discover an eruptive pattern one eruption too late. Because the eruptive pattern has failed there are now no hints for forecasting possible future activity at Kilauea, but monitoring will provide data for future predictions.

Books

Cooke-Ravina Volume of Volcanological Papers

Geological Survey of Papua New Guinea Memoir 10, R. W. Johnson (Ed.), Geological Survey of Papua New Guinea, Port Moresby, 285 pp.

Reviewed by Chris Newhall

A splendid volume entitled *Volcanism in Australasia* and edited by R. W. Johnson (Elsevier, New York, 1976) introduced many readers to volcanoes of Papua New Guinea. Now, Johnson and the Geological Survey of Papua New Guinea have published an equally splendid sequel that is a tribute to volcanologists Rob Cooke and Elias Ravina, killed during the 1979 eruption of Karkar Volcano. From Sam and Blup Blup to Bagana and beyond, 25 papers in the new work cover a wide variety of topics—including reconnaissance mapping and stratigraphic studies, interpretations of legends and old historical records, detailed studies of Karkar lavas and Rabaul pyroclastic deposits, and documentation of the precursors and characteristics of some recent eruptions. A wide variety of volcanoes is also covered, from small stratovolcanoes and cinder cones to large calderas.

Researchers of Papua New Guinea volcanism have used an innovative and pragmatic combination of historical records, geomorphology and geologic information, and in recent years petrological and geophysical data to learn a great deal about their subjects. This book captures the full scope of these studies and in so doing tells us not only about specific volcanoes but also how to study them in spite of limited resources, difficult logistics, discontinuous exposures from island to island, dense tropical vegetation, and steep soils.

In several respects the *Cooke-Ravina Volume* complements *Volcanism in Australasia* and should be read with the latter in hand. Many papers in the latter book assume familiarity with topics covered in the earlier work, e.g., tectonic and petrologic studies in Papua New Guinea. Together, these two volumes are a major step toward an updated version of the *Catalogue of Active Volcanoes for Australasia* (IAVCEI, Naples, 1978) and a comparison with the *Catalogue* shows that much has been learned over the intervening years.

A strong descriptive thread runs through the volume. This thread is both its illustrative strength and an appropriate reflection of the groundwork that needs to be done before one can get on to more interpretive studies. Descriptions of eruption precursors and characteristics are excellent. I must admit to wishing that some descriptions of older pyroclastic sequences or morphologic forms had been carried through to more interpretive overviews, but these gaps between description and interpretation can be a challenge to future workers. Several papers do go beyond description and are important contributions to an understanding of volcanic processes. A paper by McKee et al. on hydroeruptions at Karkar is an especially thorough and interesting examination of the mechanism of hydro- or phreatic eruptions, the very hazard that claimed the lives of Rob Cooke and Elias Ravina.

The volume is printed on high-quality paper stock and is clothbound. Its photographs are at once a strength and a weakness; their number and selection are excellent, but the quality of their reproduction is mixed, with many photographs blurred by poor printing. Perhaps in a second printing this fault could be corrected. Overall, the book is an excellent value at approximately \$30 (22 Kina).

The volume contains a glossary and abstracts in Tok Pisin (Papua New Guinea Pidgin) in an attempt to attract a wider Melanesian audience. At the very least this is symbolically important, and I hope that this wider audience is reached. Volcanologic studies are of interest not only to the international but the growing Papua New Guinean scientific communities, but are also of vital importance to the many people who live on or near Papua New Guinea's active volcanoes.

Chris Newhall is with the David A. Johnston Cascades Volcano Observatory, U.S. Geological Survey, Vancouver, WA 98661.

References

- Wood, C. A., and J. L. Whitford-Stark, *Bay of Islands Forest for Kilauea caldera*, *Eos*, 63, 805, 1982.
- Bascock, R. A., *A chronological code for volcanic events*, *J. Volcan. Geothermal Res.*, 4, 1, 1982.
- James L. Whitford-Stark, *Bay of Islands Forest for Kilauea caldera*, *Eos*, 63, 805, 1982.
- Geology Department, Sul Ross State University, Alpine, TX 79824.
- Charles A. Wood, *U.S. Geological Survey, Cascades Volcano Observatory, Port Moresby, PNG*.

Managing the Ocean Resources of the United States: The Role of the Federal Marine Sanctuaries Program

D. P. Finn, *Lecture Notes in Coastal and Estuarine Stud.*, vol. 2, Springer-Verlag, New York, ix + 192 pp., 1982, \$16.

Reviewed by Giulio Pontecorvo

In 1969, the Siron Commission report provided a plan for the systematic development of a national policy on marine affairs. In subsequent years no such systematic approach in a coherent marine policy was undertaken. The de facto policy approach of the 1970s was a plethora of individual legislative acts which provided specific directives for the management of the marine resources, but which left administration of the complex problems of working out the administration of areas of overlapping authority, with conflicting or inconsistent goals and jurisdictions. The major acts of the 1970s, the Fish Conservation and Management Act of 1976, the Marine Mammals and Non-Migratory Birds—The Marine Mammal Protection Act of 1972, Coastal Zone Management Act of 1972, the Endangered Species Act of 1973, Marine Protection, Research, and Sanctuaries Act of 1972, and others, are clear indications of national commitment to regulation of the marine resources. This book, *Managing the Ocean Resources of the United States*, Daniel P. Finn, is a carefully documented survey of these legislative and administrative issues that have shaped and will shape the future of the marine resources. The book is a valuable and timely work for the marine scientist, the policy maker, and the general public. It is a must-read for anyone interested in the future of the marine resources. The book is a valuable and timely work for the marine scientist, the policy maker, and the general public. It is a must-read for anyone interested in the future of the marine resources.

In turn, these case studies provide the basis for examination of a set of specific questions: "Can federal agencies, administering diverse regulatory and protective programs, formulate coherent policies and consistent decisions on marine resource development? Should specific provisions be made for special management of marine areas with especially valuable resources or a high probability of serious user or resource conflict? Is the valuable marine resources subject to legislative protection and can they be adequately protected through existing programs? How efficient is the federal management system in achieving balanced decisions?" (p. 3).

The case studies provide a complete review of the legal processes surrounding protection and implementation. With these case studies as evidence, the monograph then goes on to examine, in three more chapters, the specific issues, coordination between agencies, the problem of definition of programs, management difficulties, the institutional perspective of the managers, political pressures, etc.

This monograph is a valuable handbook for the manager of marine resources, and it is an important reference work, and also, in a sense, it is an object lesson in how not to do it. There is one serious omission in the book. In general, to focus on legal and political issues is to leave out the underlying scientific basis for action. The concept of a sanctuary requires an adequate scientific basis to justify its economic and environmental uses and to defend it against alternative uses and to give it a set of objectives that can guide management actions.

Finn has provided an important service by describing how the system worked. We need better understanding of its limitations.

Giulio Pontecorvo is with the Graduate School of Business, Columbia University, New York, NY 10027.

Classified

RATES PER LINE

Full-time insertion \$1.75, additional insertions \$1.50.

Positions Available, Services, Supplies, Courses, and Announcements: first insertion \$3.50, additional insertions \$2.75.

Student Opportunities: first insertion free, additional insertions \$1.50.

There are no discounts or commissions on classified ads. Any type of style that is not publishable is charged for at general advertising rates. Ads are published without charge on Tuesdays. Ads must be received in writing on Monday, 1 week prior to the date of publication.

Regulations to ads with box numbers should be addressed to Box 1, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D. C. 20009.

For further information, call toll free 800-424-2488 or, in the Washington, D. C., area, 462-6903.

POSITIONS AVAILABLE

Deputy Assistant Administrator for Oceanic and Atmospheric Research. The Office of Oceanic and Atmospheric Research (OAR), National Oceanic and Atmospheric Administration (NOAA), has announced the vacancy of Deputy Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base improvements of those services and products. The Deputy Assistant Administrator functions as full Deputy and also as the Assistant Administrator for Oceanic and Atmospheric Research, located in Rockville, Maryland. The Office of Oceanic and Atmospheric Research is responsible for an integrated NOAA oceanic and atmospheric research and development program. The program consists of laboratory and extramural research projects that are relevant to NOAA service and resource management programs, and that provide sound technological and scientific principles on which to base

Meetings

Announcements Southwest Water

An interdisciplinary conference on meeting the current and anticipated water needs for farms, municipalities, and industries of the Southwest will be held in Dallas, Tex., on April 3-5, 1984. Focusing on the technical, economic, financial, and legal aspects of this problem, the conference will explore eight major topics: water needs and demands, water availability, competition for water resources, strategies for increasing the availability of water, demand reduction, water conservation, water reuse, and protection of ground and surface waters.

Entitled "Water for the 21st Century: Will It Be There?" the conference will be held at Southern Methodist University in cooperation with several professional organizations and various regional, state, and federal agencies. Conference proceedings will be published.

Authors interested in presenting papers must submit one-page abstracts by August 30, 1983, to one of the separate coordinators appointed for the eight major topics of the conference. For more information contact the general chairman, Michael A. Collins, School of Engineering and Applied Science, Southern Methodist University, Dallas, TX 75275 (telephone: 214-682-3000).

Meeting Report

Aeromagnetic Data Workshop

A workshop on aeromagnetic data, sponsored by the National Geophysical Data Center (NGDC) of the National Oceanic and Atmospheric Administration, was held in Boulder, Colo., November 18-19, 1982, to evaluate the requirements for a national aeromagnetic database. The following recommendations were developed by J. R. Heitler, Woods Hole Oceanographic Institution; W. J. Hinze, Purdue University; A. M. Hittelman, ARCO Exploration Company; K. Svendsen, GRES, University of Colorado; D. M. Clark, National Geophysical Data Center; T. M. Anderson, Union Oil of California; and P. Chisner and R. Van Nieuwenhuise, Cities Service.

A national aeromagnetic anomaly data file of available digital data and a central distribution center are urgently needed in the United States.

Magnetic methods have a long and successful history of mapping earth's crust for both scientific and applied objectives. Probably no other geophysical data sets provide as much information on as broad a range of geological problems, although it seldom provides a unique answer to any one problem. The magnetic method is primarily directed toward mapping the crystalline basement and igneous intrusive and extrusive rocks. These rocks are largely unknown because they are hidden from direct geologic observations by a cover of younger sedimentary rock formations and because only limited deep drilling has been conducted in these areas.

Thus, the magnetic method is used to map the structure and petrologic variations within

the crystalline rocks and in so doing attacks a wide variety of problems dealing with the geologic and tectonic history of the crust. Magnetic data have traditionally played a major role in petroleum exploration. In recent years, magnetic data have been applied to a host of new problems such as geothermal exploration, seismic regionalization, site stability, waste disposal, and plate tectonic studies. Furthermore, the ability to accurately observe magnetic data from airborne platforms has permitted the acquisition of data over difficult terrain and the correlation of continental and marine geological patterns.

It is clear that the need for magnetic anomaly data is broad and are expanding beyond the purpose for which they were acquired. In fact, we have now reached a point where data takers are no longer the principal users; often the nonspecialist, who has no direct access to the data except through repositories, is a principal user. These data users in particular are interested in multiple data files for correlation purposes. Multiple data files are most effectively handled by a central repository. In the past decade, vast areas of the United States have been aeromagnetically surveyed at several different specifications by public agencies. Also, an increasing amount of anomaly data is available in digital form. It is important that these data be put in a repository before they are degraded, filtered, or altered in a fashion that loses information that may be useful to another user.

2. A standard data-exchange format is needed.

The establishment of a common digital format is important because nonstandard formats hamper data archiving and exchange. A standard format will accelerate the transfer of data, set a standard for the documentation, facilitate comparisons with other geophysical data, establish data precision requirements of the scientific community, and reduce the data deterioration caused by reformatting errors.

For several reasons, the use of a format structure similar to that of the marine geophysical data-exchange format (known as MGD77) is desirable. The MGD77 format contains descriptive data (marine magnetism, gravity, and bathymetry data collected at sea) and forms the foundation for the Geophysical Data System (GEODAS), developed by the National Geophysical Data Center. GEODAS performs a wide variety of file management functions (e.g., field validation checks) and supports an online inventory system producing such products as trackline plots and tabular summaries.

Though most of the data may result from national programs, collection may not be limited to U.S. data. Ultimately, some non-U.S. data will be included, and this could become a World Data Center function. Because format and instructions for submission of data to the World Data Centers are formally given in the "ICSU Guide to International Data Exchange," we recommend that the ICNU panel on World Data Centers include the class of airborne data in its next edition of the guide. NGDC can help draft an appropriate section on airborne data.

We also recommend that the Society of Exploration Geophysicists (SEG) endorse the proposal. Consequently, SEG is being approached to sponsor this initiative and establish a working group to develop such a format.

3. A national magnetic anomaly survey inventory is a necessary element in establishing a national magnetic anomaly data base. Currently, most of the publicly available magnetic anomaly data and maps have been acquired by the U.S. Geological Survey, U.S. Navy, U.S. Department of Energy, academic institutions, and various state agencies over a 35-year period. The specifications of data acquisition and reduction, as well as the size of the survey area, are variable, and its comprehensive catalog inventory of these surveys and their specifications has been compiled.

4. An external advisory committee could be of great value to NGDC and should be established.

NGDC, which has an excellent record of serving the user community, has weathered all the adverse criticisms that were leveled against data centers a decade ago. They have effectively used a variety of groups and workshops to further their work. However, because of the large amounts of aeromagnetic data that should become available, a standing advisory committee is recommended to ensure that the data management efforts meet national requirements and to aid in selecting new data. An external committee should be more effective than NGDC in acquiring data from industry, academia, and other government agencies.

The National Geophysical Data Center

AGU

Supporting Members

To Order: The order number can be found at the end of each abstract; use all digits when ordering. Only papers with order numbers are available from AGU. Cost: \$3.50 for the first article and \$1.00 for each additional article in the same order. Payment must accompany order. Deposit accounts available.

Send your order to:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20039

Aeronomy

0140 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented. The analytical cross sections for the production of ionospheric parameters are presented. The analytical cross sections for the production of ionospheric parameters are presented.

0150 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0160 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0170 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0180 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0190 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0200 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0210 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0220 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0230 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

AGU

Supporting Members

The following individuals have been added to the list of Supporting Members. The full list was last published in the May 10, 1983, *EOS*.

Life Supporting Members

Arnelian Sullivan

Individual Supporting Members

Lloyd E. Brumman
William D. Gauder
Sigmund I. Hammer
John C. Maxwell

plans to publish the proceedings of the workshop that will include in-depth contributions of all speakers and many of the other participants.

This meeting report was contributed by David M. Clark, National Geophysical Data Center, Allen M. Hittelman, ARCO Exploration Company.

AGU

Supporting Members

To Order: The order number can be found at the end of each abstract; use all digits when ordering. Only papers with order numbers are available from AGU. Cost: \$3.50 for the first article and \$1.00 for each additional article in the same order. Payment must accompany order. Deposit accounts available.

Send your order to:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20039

Aeronomy

0140 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0150 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0160 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0170 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0180 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0190 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0200 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0210 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0220 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0230 (Abstracts and scattering of radiation) ANALYTICAL SCATTERING ASPECTS OF PRODUCTION SPECTRA AND IONOSPHERIC PARAMETERS. R. A. Rasmussen and M. H. Rasmussen, University of Alaska, Fairbanks, Alaska, 99701. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

Zuber Canyon (Zuber Valley), near Vancouver, B.C. Canada, was a frequenty-occurring event using the 1984-85 season. For the survey, we applied a 4.5 to 100-m diameter circular beam, generating a 100-m diameter beam. The frequency range was 10 to 100 Hz. With 100 Hz, we were able to obtain a magnetic reference for a 100-m diameter beam. We were able to obtain a magnetic reference for a 100-m diameter beam. We were able to obtain a magnetic reference for a 100-m diameter beam.

I also derive the response of a buried point source for a layered medium bounded by a free surface, a homogeneous half-space, and for a layered medium bounded by a homogeneous half-space. These general results can be used for a variety of applications. I use a multi-dimensional Fourier transform to solve the problem of a point source in a layered medium. I use a multi-dimensional Fourier transform to solve the problem of a point source in a layered medium.

The decomposition into upwelling and downwelling waves breaks down for horizontally traveling waves. The reflection and transmission matrices do not exist in this case. This fact is used to derive dispersion relationships for channel waves and surface waves. The reflection and transmission matrices do not exist in this case. This fact is used to derive dispersion relationships for channel waves and surface waves.

3930 Local Gravity Anomalies. GEOLOGICAL SIGNIFICANCE OF SURFACE GRAVITY MEASUREMENTS IN THE VICINITY OF THE ILLINOIS DRILL HOLE. D. M. Clark, S. O. Collins (Department of Geological Sciences, University of Texas at Austin, Austin, Texas 78798), and H. J. Riney.

A gravity study of northwestern Illinois and southern Indiana was undertaken to provide a detailed three-dimensional picture of the Precambrian granite body and the Illinois drill hole. Gravity data were collected from 1978 to 1982. The data were collected from 1978 to 1982. The data were collected from 1978 to 1982. The data were collected from 1978 to 1982.

0100 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0110 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0120 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0130 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0140 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0150 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0160 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0170 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0180 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0190 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0200 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0210 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0220 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0230 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0240 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0250 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0260 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0270 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0280 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

metrices are defined, using the two propagation invariants, a number of symmetry properties of the reflection and transmission matrices are derived. For a layered medium bounded by a free surface, a homogeneous half-space, and for a layered medium bounded by a homogeneous half-space. These general results can be used for a variety of applications. I use a multi-dimensional Fourier transform to solve the problem of a point source in a layered medium. I use a multi-dimensional Fourier transform to solve the problem of a point source in a layered medium.

The decomposition into upwelling and downwelling waves breaks down for horizontally traveling waves. The reflection and transmission matrices do not exist in this case. This fact is used to derive dispersion relationships for channel waves and surface waves. The reflection and transmission matrices do not exist in this case. This fact is used to derive dispersion relationships for channel waves and surface waves.

3930 Local Gravity Anomalies. GEOLOGICAL SIGNIFICANCE OF SURFACE GRAVITY MEASUREMENTS IN THE VICINITY OF THE ILLINOIS DRILL HOLE. D. M. Clark, S. O. Collins (Department of Geological Sciences, University of Texas at Austin, Austin, Texas 78798), and H. J. Riney.

A gravity study of northwestern Illinois and southern Indiana was undertaken to provide a detailed three-dimensional picture of the Precambrian granite body and the Illinois drill hole. Gravity data were collected from 1978 to 1982. The data were collected from 1978 to 1982. The data were collected from 1978 to 1982. The data were collected from 1978 to 1982.

0100 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0110 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0120 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0130 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0140 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0150 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0160 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0170 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0180 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0190 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0200 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0210 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0220 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0230 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.

0240 Seismic activity. GEOPHYSICAL ASPECTS OF SEISMIC ACTIVITY IN A TECTONICALLY ACTIVE REGION. J. R. Heitler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 01961. There are a number of analytical scattering cross sections for the production of ionospheric parameters. These have been used by various authors to calculate degradation of production spectra. The analytical cross sections for the production of ionospheric parameters are presented.